

WHAT IS CLAIMED IS:

- 1 1. An objective having a first field plane, an
2 intermediate image plane, and a second field plane, the
3 objective comprising

4 a first partial objective having a first, convex mirror
5 with a first central mirror aperture and a second, concave
6 mirror with a second central mirror aperture; and

7 a second partial objective having a third, concave
8 mirror with a third central mirror aperture and a fourth,
9 concave mirror with a fourth central mirror aperture;

10 wherein the first field plane and the intermediate
11 image plane are conjugate planes relative to the first partial
12 objective, and the intermediate image plane and the second
13 field plane are conjugate planes relative to the second partial
14 objective,

15 wherein the first mirror has a first axial distance
16 from the second mirror, the second mirror has a second axial
17 distance from the intermediate image, and said first and second
18 axial distances have a ratio between 0.95 and 1.05 relative to
19 each other; wherein the third mirror has a third axial distance
20 Z_{M3-IM} from the second field plane, and said third axial
21 distance conforms to the relationship

22 $0.03 \cdot D_{M3} + 5.0 \text{ mm} < Z_{M3-IM} < \frac{0.25 \cdot D_{M3}}{\tan(\arcsin(NA))},$

23 NA representing a numerical aperture NA in the second field
24 plane, and D_{M3} representing a diameter of the third mirror;
25 and wherein further the second field plane has a fourth axial
26 distance from the first field plane, and the objective has a
27 Petzval radius whose absolute value is greater than said fourth
28 axial distance.

1 2. The objective of claim 1, wherein light rays that
2 are not vignetted by said first, second, third and fourth
3 central mirror apertures define a minimum aperture angle in the
4 second field plane, wherein an aperture obscuration is defined
5 as the ratio between the sine of said minimum aperture angle
6 and said numerical aperture NA, and wherein the aperture
7 obscuration has a value of less than 0.6.

1 3. The objective of claim 2, wherein the ratio of the
2 numerical aperture NA to the aperture obscuration is greater
3 than 1.2.

1 4. The objective of claim 1, wherein the numerical
2 aperture NA is greater than 0.3.

1 5. The objective of claim 1, wherein the objective has
2 an overall imaging ratio greater than 4:1 between the first
3 field plane and the second field plane.

1 6. The objective of claim 1, wherein the objective has
2 a first imaging ratio greater than 1:1 between the first field
3 plane and the intermediate image, and a second imaging ratio
4 greater than 1:1 between the intermediate image and the second
5 field plane.

1 7. The objective of claim 1, wherein the objective has
2 a first imaging ratio greater than 3:1 between the first field
3 plane and the intermediate image.

1 8. The objective of claim 1, wherein the first mirror
2 has a first diameter and the second mirror has a second
3 diameter, and wherein said second diameter has a ratio greater
4 than 3:1 to said first diameter.

1 9. The objective of claim 1, wherein the fourth mirror
2 has a fifth axial distance from the first mirror, and wherein
3 said fifth axial distance is less than 10 percent of the fourth
4 axial distance.

1 10. The objective of claim 1, wherein the objective
2 consists of the first, second, third and fourth mirrors.

1 11. The objective of claim 1, further comprising a
2 fifth mirror with a fifth central mirror aperture and a sixth
3 mirror with a sixth central mirror aperture, wherein the sixth
4 mirror follows the fifth mirror in a light path between the
5 intermediate image and the third mirror, and wherein a further
6 intermediate image is formed in said light path between the
7 sixth mirror and the third mirror.

1 12. The objective of claim 11, wherein the fifth and
2 sixth mirrors are concave mirrors.

1 13. The objective of claim 11, wherein the fifth
2 mirror has a sixth axial distance from the further intermediate
3 image, and wherein said sixth axial distance is less than 5
4 percent of the fourth axial distance.

1 14. The objective of claim 11, wherein the sixth
2 mirror has a seventh axial distance from the first mirror, and
3 wherein said seventh axial distance is less than 10 percent of

4 the fourth axial distance.

1 15. The objective of claim 11, wherein the fifth
2 mirror has an eighth axial distance from the fourth mirror, and
3 wherein said eighth axial distance is less than 10 percent of
4 the fourth axial distance.

1 16. The objective of claim 1, wherein the objective
2 consists of the first, second, third, fourth, fifth and sixth
3 mirrors.

1 17. The objective of claim 1, wherein the objective
2 has a free working distance FWD_{obj} between the first field plane
3 and the first partial objective, said free working distance
4 FWD_{obj} being greater than 20 percent of the fourth axial
5 distance.

1 18. The objective of claim 1, wherein aberrations are
2 corrected in the second field plane within a field of more than
3 1.0 mm diameter.

1 19. The objective of claim 1, wherein the objective
2 has a spherical aberration in the second field plane, and

3 wherein said spherical aberration has a ratio of less than 10^{-5}
4 to the fourth axial distance.

1 20. The objective of claim 1, wherein the fourth axial
2 distance is at most 3000 millimeters.

1 21. The objective of claim 1, wherein the objective
2 projects a reduced image of an object in the first field plane
3 into the second field plane.

1 22. A lithographic projection apparatus comprising an
2 illumination system and the objective of claim 21, wherein the
3 object is a mask carrying a microstructure and wherein a
4 photosensitive substrate is arranged in the second field plane
5 to receive said reduced image.

1 23. A method of exposing photosensitive substrates in
2 the lithographic projection apparatus of claim 22, wherein the
3 method comprises:

4 - illuminating the mask by means of the illumination system
5 with a ray pencil,
6 - modulating the ray pencil by means of the mask, and
7 - projecting the modulated ray pencil onto the photosensitive

8 substrate by means of the objective.

1 24. A lithographic projection apparatus comprising an
2 illumination system and the objective of claim 21, wherein the
3 object is a controllable array of micromirrors and wherein a
4 photosensitive substrate is arranged in the second field plane
5 to receive said reduced image.

1 25. A method of exposing photosensitive substrates in
2 the lithographic projection apparatus of claim 24, wherein the
3 method comprises:

- 4 - illuminating the controllable micromirror array by means of
5 the illumination system,
- 6 - reflecting ray pencils from the micromirrors,
- 7 - by means of a control unit, driving the micromirrors in
8 accordance with a prescribed pattern in such a way that only
9 a part of the reflected ray pencils will fall on the photo-
10 sensitive substrate through the objective, and
- 11 - projecting the reflected ray pencils onto the photosensitive
12 substrate by means of the objective.

1 26. The objective of claim 1, wherein the objective
2 projects an enlarged image of an object in the second field

3 plane into the first field plane.

1 27. An inspection system, comprising the objective of
2 claim 26, an illumination system, and an observation unit with
3 an entry surface, wherein said entry surface is located in the
4 first field plane to receive said enlarged image projected by
5 the objective.

1 28. A method of inspecting an object by means of the
2 inspection system of claim 27, wherein the object to be
3 inspected has a surface area carrying structures, the method
4 comprising the steps:

5 - illuminating said surface area by means of the illumination
6 system with a ray pencil, with the result that rays of the
7 ray pencil are diffracted in different directions by said
8 structures,
9 - projecting the diffracted rays onto the entry surface of the
10 observation unit.

1 29. An objective having a first field plane, an
2 intermediate image plane and a second field plane, the
3 objective comprising
4 a first partial objective having a first mirror with a

5 first central mirror aperture and a second mirror with a second
6 central mirror aperture; and

7 a second partial objective having a third mirror with a
8 third central mirror aperture and a fourth mirror with a fourth
9 central mirror aperture;

10 wherein the first field plane and the intermediate
11 image plane are conjugate planes relative to the first partial
12 objective;

13 wherein the intermediate image plane and the second
14 field plane are conjugate planes relative to the second partial
15 objective;

16 wherein the objective has a first imaging ratio greater
17 than 1:1 between the first field plane and the intermediate
18 image, and a second imaging ratio greater than 1:1 between the
19 intermediate image and the second field plane.

1 30. The objective of claim 29, wherein the objective
2 has a first imaging ratio greater than 3:1 between the first
3 field plane and the intermediate image.

1 31. The objective of claim 29, wherein the first
2 mirror has a first diameter and the second mirror has a second
3 diameter, and wherein said second diameter has a ratio greater

4 than 3:1 to said first diameter.

1 32. The objective of claim 29, wherein the objective
2 has an overall imaging ratio greater than 4:1 between the first
3 field plane and the second field plane.

1 33. The objective of claim 29, wherein light rays that
2 are not vignetted by said first, second, third and fourth
3 central mirror apertures define a minimum aperture angle in the
4 second field plane, wherein an aperture obscuration is defined
5 as the ratio between the sine of said minimum aperture angle
6 and said numerical aperture NA, and wherein the aperture
7 obscuration has a value of less than 0.6.

1 34. The objective of claim 33, wherein the ratio of
2 the numerical aperture NA to the aperture obscuration is
3 greater than 1.2.

1 35. The objective of claim 29, wherein the numerical
2 aperture NA is greater than 0.3.

1 36. The objective of claim 29, wherein the first
2 mirror is a convex mirror, the second mirror is a concave

3 mirror, the third mirror is a concave mirror, and the fourth
4 mirror is a concave mirror.

1 37. An objective having a first field plane, a first
2 intermediate image plane, a second intermediate image plane,
3 and a second field plane, the objective comprising
4 a first partial objective having a first mirror with a
5 first central mirror aperture and a second mirror with a second
6 central mirror aperture;
7 a second partial objective having a third mirror with a
8 third central mirror aperture and a fourth mirror with a fourth
9 central mirror aperture; and
10 a third partial objective having a fifth mirror with a
11 fifth central mirror aperture and a sixth mirror with a sixth
12 central mirror aperture
13 wherein the first field plane and the first
14 intermediate image plane are conjugate planes relative to the
15 first partial objective;
16 wherein the first intermediate image plane and the
17 second intermediate image plane are conjugate planes relative
18 to the second partial objective;
19 wherein the second intermediate image plane and the
20 second field plane are conjugate planes relative to the third

21 partial objective.

1 38. The objective of claim 37,
2 wherein the objective has a first imaging ratio greater
3 than 1:1 between the first field plane and the first
4 intermediate image, and a second imaging ratio greater than 1:1
5 between the first intermediate image and the second field
6 plane.

1 39. The objective of claim 37, wherein the objective
2 has a first imaging ratio greater than 3:1 between the first
3 field plane and the first intermediate image.

1 40. The objective of claim 37, wherein the objective
2 has an overall imaging ratio greater than 4:1 between the first
3 field plane and the second field plane.

1 41. The objective of claim 37, wherein the numerical
2 aperture NA is greater than 0.3.

1 42. The objective of claim 37, wherein the first
2 mirror is a convex mirror, the second mirror is a concave
3 mirror, the third mirror is a concave mirror, the fourth mirror

4 is a concave mirror, the fifth mirror is a concave mirror and
5 the sixth mirror is a concave mirror.

1 43. The objective of claim 37, wherein the first
2 mirror is a convex mirror, the second mirror is a concave
3 mirror, the third mirror is a concave mirror, the fourth mirror
4 is a concave mirror, the fifth mirror is a convex mirror and
5 the sixth mirror is a concave mirror.